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# MUNICIPAL AND INDUSTRIAL WATER REQUIREMENTS LAVON RESERVOIR EAST FORK OF THE TRINITY RIVER TEXAS

Public Health Service
Dallas, Texas

January 1961

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# MUNICIPAL AND INDUSTRIAL WATER REQUIREMENTS

LAVON RESERVOIR

EAST FORK OF THE TRINITY RIVER

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DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service, Region VII
Dallas, Texas

In Cooperation with the

DEPARTMENT OF THE ARMY
U. S. Army Engineer District - Fort Worth, Texas

JANUARY 1961

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# I. INTRODUCTION

## Authority

This report was prepared in accordance with the Memorandum of Agreement dated November 4, 1958, which provides that the Department of Health, Education, and Welfare assist the Department of the Army in implementing the Water Supply Act of 1958.

The study of the Lavon Reservoir was authorized by a letter from the District Engineer, Fort Worth District, Corps of Engineers to the Regional Engineer, Region VII, Public Health Service, dated June 8, 1959.

## Purpose and Scope

The above letter requested the views and recommendations of the Public Health Service on present and prospective needs for municipal and industrial water supply for Dallas and in surrounding area and desirability of meeting these needs by modification of Lavon Reservoir.

## Acknowledgments

Grateful acknowledgment is made for the assistance of the Texas State Department of Health; the Texas Board of Water Engineers; the U. S. Study Commission - Texas; the Fort Worth District of the Corps of Engineers; the North Texas Municipal Water District; Freese, Nichols, and Endress, Consulting Engineers, Fort Worth, Texas; Forrest and Cotton, Inc., Consulting Engineers, Dallas, Texas; Homer Hunter and Associates, Consulting Engineers, Dallas, Texas; City officials of the cities of Dallas, Garland, and Mesquite, Texas, and others who provided information and data used in this study.

# II. SUMMARY AND CONCLUSIONS

## Summary

1. Existing Lavon Reservoir is located on the East Fork of the Trinity River, about seven miles north of the town of Rockwall in north central Texas. This report deals with the desirability of enlarging it to meet future water demands of the study area.

2. The study area consists of Collin and Rockwall Counties, the northeast corner of Dallas County, and the northwest portion of Kaufman County.

3. The North Texas Municipal Water District is the major water user in the area, and it leases the conservation pool in Lavon Reservoir. It is composed of the following ten member cities: Farmersville, Forney, Garland, Mesquite, McKinney, Plano, Princeton, Rockwall, Royse City, and Wylie, all of which obtain their water from the District. In addition, there are two customer cities: Dallas, which contracts for 10 mgd with 7.5 mgd minimum, and the town of Fate, which contracts for a minimum of 7,500 gal/day. The majority of the waste produced is municipal from the above named member and customer cities. There are no large water-using industries in the area.

4. The existing reservoir has a conservation pool capacity of 100,000 acre-feet, with a corresponding firm yield of 44 mgd, as estimated by the Corps of Engineers. The proposed enlargement would increase the water supply storage to 360,000 acre-feet and the yield to 90 mgd.

5. The population of the area has been projected to be 411,000 in 2010, or almost a fivefold increase of the 1960 population of 83,500.

6. The area is divided into a metropolitan and a non-metropolitan group of municipalities. The per capita consumption rates for the two groups are projected to be 180 gallons per day and 150 gallons per day respectively in the year 2010.

## Conclusions

1. Using the values given in (5) and (6) of the summary, the future municipal and industrial water requirements of the North Texas Municipal Water District are projected as 83.2 mgd in 2010 and an intermediate projection of 36.7 mgd for 1975. It is assumed that the city of Dallas will purchase all excess water available from Lavon Reservoir through the District, bringing the total demand for the year 2010 to 90 mgd.

2. The existing reservoir is adequate as a source of water for the study area until about the year 1980.

3. Municipal and industrial water requirements for 2010 can be met by providing additional storage in Lavon Reservoir or by including storage in the proposed Cooper Reservoir on the Sulphur River and transferring the water to Lavon Reservoir by a system of pumping plants and a pipe line.

4. The Trinity River and some of its tributaries in the vicinity of the study area are polluted at present and will remain so in the future unless additional corrective measures are developed and applied.

5. The 1970 annual value of augmented storage to increase the firm yield of Lavon Reservoir from 44 mgd to 90 mgd is $755,000, or 4.49¢ per 1,000 gallons.

# III. DESCRIPTION OF PROJECT

## Location

The existing Lavon Dam and Reservoir project is located on the East Fork of the Trinity River, about seven miles north of Rockwall in Collin County, Texas. The contributing watershed consists of 777 square miles principally located in Collin County and extending into Grayson, Fannin, and Hunt Counties, as shown by Figure 1.

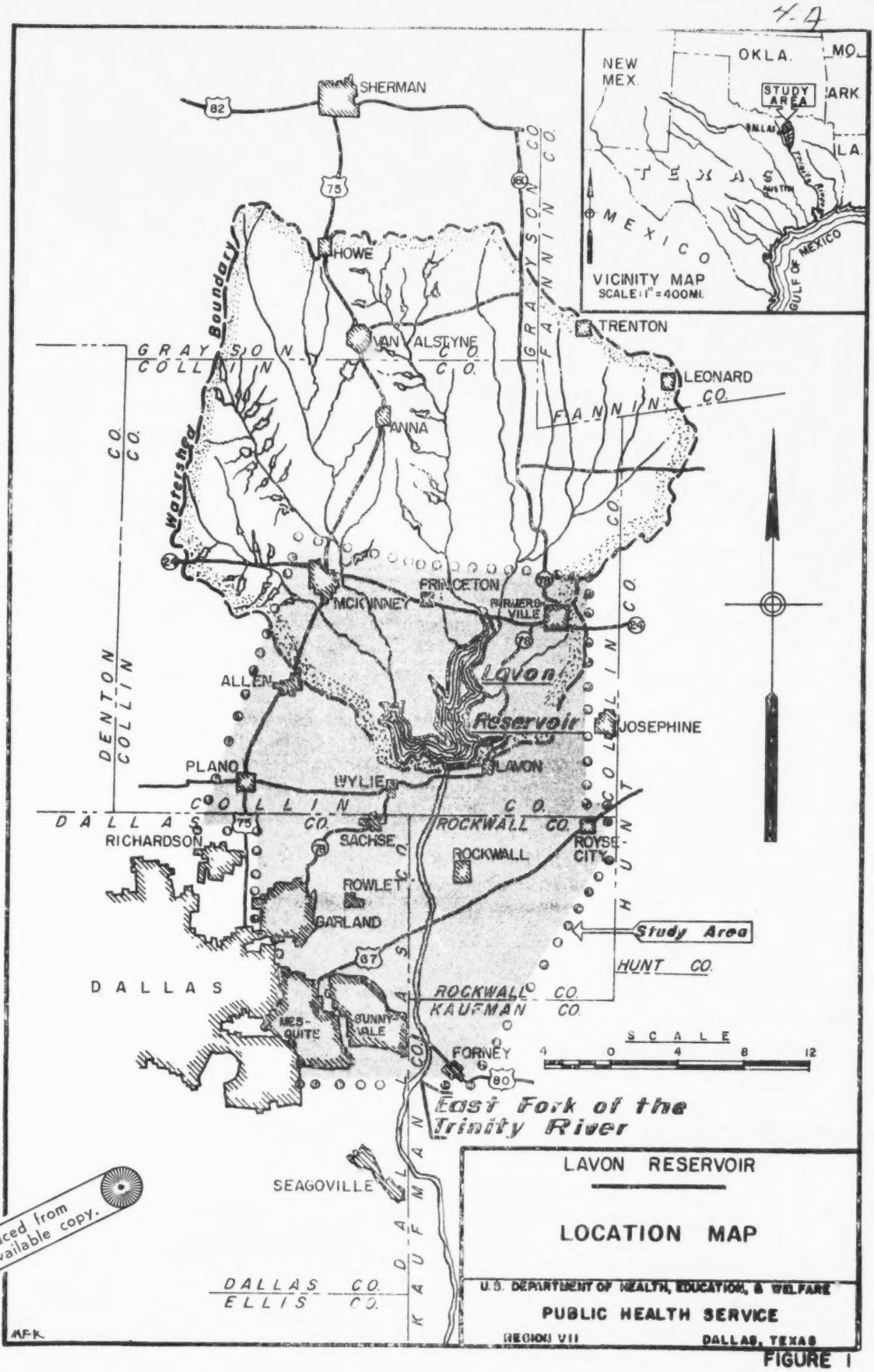
## Purpose

Lavon Reservoir was authorized for construction by the River and Harbor Act, approved March 2, 1945, and as amended by the River and Harbor Act, approved July 24, 1946. Construction began in January, 1948, and the project was placed in full operation for flood control in March, 1954.

The reservoir provides 275,600 acre-feet of storage for flood control; 100,000 acre-feet for conservation; and 47,800 acre-feet as dead storage. The dam is of earth fill construction with a concrete spillway section and has an overall length of 9,499 feet. Flows from the flood control pool are controlled by twelve tainter gates, each 40 feet long and 28 feet high above the weir crest. Normal release of low flows is accomplished through five 36 inch gate-controlled conduits. A water supply intake for the North Texas Municipal Water District is located approximately 1,200 feet upstream of the spillway. Withdrawals are controlled by six 48 inch diameter sluice gates at different levels and the intake is connected to the District's raw water pumping plant.

## Stream Flow

Stream flow measurements on the East Fork of the Trinity River were begun in October, 1923, near Rockwall by the U. S. Geological Survey and are continuous until September, 1954, when the closure of the Lavon Dam caused abandonment of the gage in favor of a downstream location near Crandall. The Rockwall station records show an average runoff of 345,300 acre-feet. During the period from 1924 to 1954, the minimum was 45,700 acre-feet in 1925, and the maximum was 941,700 acre-feet in 1946.




LAVON RESERVOIR

LOCATION MAP

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PUBLIC HEALTH SERVICE
REGION VII DALLAS, TEXAS

FIGURE 1

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## Water Quality

Water impounded in Lake Lavon in 1959 was of suitable quality for most municipal and industrial uses as shown in Table 1. [5/] Data presented show characteristics varying within rather narrow ranges over the entire year with moderate hardness (114 mg/l - 142 mg/l) and total solids (residue on evaporation -- 235 mg/l - 355 mg/l). Iron and manganese were low during this period. No appreciable change in quality is anticipated.

## Pertinent Data

A preliminary estimate by the Corps of Engineers gives the firm yield of the enlarged Lake Lavon as 90 mgd and the capacity of the conservation pool as 360,000 acre-feet. This compares with a firm yield of 44 mgd from the existing conservation pool capacity of 100,000 acre-feet.

The increase in capacity is to be accomplished by raising the spillway crest 11 feet, from elevation 462.0 to elevation 473.0.

Table 1 5/

Analysis of Raw Water from Lake Lavon
1959

| Item | Quantity | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sept | Oct | Nov | Dec | Aug |
| Turbidity | 35 | 38 | 44 | 51 | 49 | 37 | 38 | 38 | 39 | 42 | 44 | 44 | 41 |
| Residue on Evap. (103°C) | 315 | 325 | 327 | 331 | 355 | 291 | 272 | 276 | 235 | 274 | 240 | 268 | 292 |
| Silica ($SiO_2$) | 4.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 4.0 | 4.0 | 3.0 | 3.0 | 3.2 |
| Iron (Fe) | 0.3 | 0.1 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.3 | 0.3 | 0.2 | 0.2 |
| Aluminum (Al) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Calcium (Ca) | 44.6 | 50.2 | 47.2 | 48.0 | 46.4 | 46.4 | 41.6 | 41.4 | 44.2 | 43.4 | 41.6 | 44.0 | 44.9 |
| Magnesium (Mg) | 5.4 | 3.0 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.2 | 4.2 | 3.7 | 4.8 | 4.8 | 4.5 |
| Sodium + Potassium as Na | 27.8 | 22.8 | 24.6 | 27.4 | 25.8 | 18.1 | 15.6 | 18.5 | 25.9 | 14.7 | 14.9 | 18.1 | 21.2 |
| Bicarbonate ($HCO_3$) | 116.4 | 146.6 | 151.5 | 156.3 | 153.7 | 152.5 | 132.0 | 131.9 | 132.0 | 133.2 | 131.7 | 136.0 | 142.0 |
| Carbonate ($CO_3$) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Hydroxide (OH) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Sulphate ($SO_4$) | 61.4 | 54.1 | 55.4 | 57.0 | 49.9 | 38.0 | 34.0 | 37.0 | 45.0 | 34.0 | 36.0 | 45.0 | 45.5 |
| Chloride (Cl) | 8.0 | 8.0 | 8.0 | 8.0 | 10.0 | 8.0 | 10.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.2 |
| Nitrate ($NO_3$) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Langlier Index | +0.5 | +0.5 | +1.0 | +1.0 | +1.0 | +0.1 | +0.1 | --- | 0.0 | +0.2 | +1.0 | +1.0 | +0.5 |
| M. O. Alkalinity as $CaCO_3$ | 120.0 | 120.0 | 124.0 | 128.0 | 126.0 | 125.0 | 108.0 | 108.0 | 108.0 | 109.0 | 108.0 | 112.0 | 116.2 |
| Phenolphathalein Alkalinity | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Non-Carbonate Hardness as $CaCO_3$ | 14.0 | 20.0 | 12.0 | 14.0 | 10.0 | 10.0 | 12.0 | 6.0 | 18.0 | 15.0 | 20.0 | 24.0 | 14.6 |
| Calculated Hardness as $CaCO_3$ | 134.0 | 140.0 | 134.0 | 142.0 | 136.0 | 135.0 | 120.0 | 114.0 | 126.0 | 124.0 | 128.0 | 136.0 | 130.8 |
| pH | 8.4 | 8.4 | 8.4 | 8.4 | 8.4 | 8.3 | 8.3 | 8.3 | 8.4 | 8.3 | 8.3 | 8.3 | 8.35 |
| Fluoride (F) | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |

Note: All samples for analysis obtained on the 15th of each month.

Quantities are in parts per million.

# IV. DESCRIPTION OF STUDY AREA

## Location and Boundaries

The study area consists primarily of Collin and Rockwall Counties, the northeast portion of Dallas County, and the northwest portion of Kaufman County. It is located in the service area of the North Texas Municipal Water District as shown in Figure 1.

## Geography

The topography of the area is gently rolling in the upper portion of the watershed, becoming generally flatter in the lower portion.

Except for small areas of alluvium and coastal prairie soils near the mouth, the watershed of the East Fork lies almost entirely within the fertile "Blackland Prairie" soil region. 6/

Upstream of the reservoir the slope of the river averages 5.7 feet per mile. The stream bed is generally narrow, shallow, and choked with debris.

## Climate

The study area has a mild climate. The mean annual temperature is 65° F., the average annual rainfall is 40 inches, and the growing season lasts for 230 days. 7/

## Principal Communities and Industries

The area of the watershed is characterized by small, primarily agricultural communities; however, its proximity to metropolitan Dallas must be considered in an analysis of area water requirements.

In 1951, a special act of the 52nd Texas Legislature authorized the formation of the North Texas Municipal Water District, which is composed of the following ten member cities: Plano, Princeton, Rockwall, Royse City, Wylie, Farmersville, Forney, McKinney, Garland, and

Mesquite, the latter two being residential suburbs of Dallas. The District obtained permit from the State Board of Water Engineers to lease 100,000 acre-feet of conservation storage in Lavon Reservoir. Revenue bonds were sold and the District constructed a treatment facility and transmission network capable of serving the ten member cities, plus the town of Fate, with treated water. In addition, the District contracted with the city of Dallas to provide 10 mgd with a 7.5 mgd minimum.

It is assumed for this study that, in the future, the District will serve the northeast portion of Dallas County as shown in Figure 1 in addition to its member cities and possibly other cities on a contract basis with water from an enlarged Lavon Reservoir. It is further assumed that the District will act for all local interests receiving water from Lavon.

Principal area industries include agriculture, aircraft, electronics, apparel, and food processing.

# V. ECONOMICS AND POPULATION

## Extractive Industries

Agriculture is the most important activity in the study area excluding Dallas County. The tri-county area of Collin, Kaufman, and Rockwall Counties contains some of the State's best farm land. Although the number of farms, as well as the acreage of cropland harvested has decreased steadily from 1945, the value of crops harvested and livestock sold increased in 1949 and showed only a 4.6 per cent overall drop from 1944 to 1954. Dollar values have been adjusted to the 1944 base for comparison in Table 2. [1,2,]

Table 2 [1,2]

Value of Crops and Livestock Sold in Collin, Rockwall, and Kaufman Counties, Texas 1944, 1949, 1954

(Values are in thousands of dollars and adjusted to the 1944 base)

| Year | Value of Crops Sold | Value of Livestock Sold | Total |
|---|---|---|---|
| 1944 | 13,888 | 4,272 | 18,160 |
| 1949 | 17,467 | 4,083 | 21,550 |
| 1954 | 12,877 | 4,447 | 17,324 |

Farm labor for the tri-county area dropped from 7,900 in 1955 to 7,725 in 1956, to a low of 7,400 in 1958, and came up to the 1955 level of 7,900 in 1959.

Agriculture in the Dallas County portion of the study area is rapidly decreasing due to urbanization.

Mineral production in the study area accounts for only a small portion of the area's economy. Table 3 [4] shows minerals produced in order of value by counties for the years 1953, 1954, 1957, and 1958.

All exploratory oil wells drilled in the area in 1958 were "dry holes."

The most important mineral resource of the area is limestone, a raw material in the manufacture of Portland cement.

Table 3 [4]

Value of Mineral Production
Collin, Dallas, Kaufman, and Rockwall Counties, Texas
1953, 1954, 1957, and 1958

(Figures in thousands of dollars not adjusted for time)

| County | 1953 | 1954 | 1957 | 1958 | Minerals in Order of Value |
|---|---|---|---|---|---|
| Collin | -- | 7.4 | 107.6 | -- | Stone |
| Dallas | 11,293.4 | 17,400.8 | 17,818.9 | 23,234.3 | Cement, sand and gravel, stone, clays, gem stones |
| Kaufman | 4,350.4 | 3,861.9 | 3,368.6 | 2,804.7 | Petroleum, stone, sand and gravel |
| Rockwall | -- | 39.3 | 16.2 | -- | Stone |
| TOTAL | incom-plete | 21,309.4 | 21,311.3 | incom-plete | |

## Manufacturing [8]

The manufacturing base of the study area has had an expanding trend. Average plant size, the number of employees and the value of the output have all increased, as shown in Table 4.

Table 4 [8/]

Number of Employees and Value Added by Manufacture
Dallas County and Collin, Rockwall and Kaufman County Group
1947, 1954, and 1958

Number Employed

| Year | Collin County | Rockwall County | Kaufman County | Total Tri-County Area | Dallas County |
|---|---|---|---|---|---|
| 1947 | 1,117 | 10 | 415 | 1,542 | 38,828 |
| 1954 | 1,554 | 90 | 926 | 2,570 | 72,770 |
| 1958 | 1,637 | N.R. | 736 | 2,373+ | 85,930 |

Value Added by Manufacture ($1,000)

| | | | | | |
|---|---|---|---|---|---|
| 1947 | $4,327 | $32 | $1,274 | $ 5,633 | $238,839 |
| 1954 | 5,597 | N.R. | 4,594 | 10,191+ | 508,271 |
| 1958 | 7,612 | N.R. | 3,859 | 11,471+ | 804,381 |

(Dollar values are not adjusted for time)

The types of manufacturing are varied and most establishments in the tri-county area are small. None of the industries represented are large water users. The Bureau of Business Research of the University of Texas, in a report to Dallas County, Texas, found that there were no large water consuming industries in the county, and strongly advised that none be solicited for location in Dallas County. Since Dallas County and the tri-county area will probably share some of the same sources for water in the future, the advice of the Bureau may apply to the entire study area. Table 5 [8/] shows distribution of manufacturers by type and size, with food and kindred products ranking highest in number of plants and employees and printing and publishing ranking second.

Table 5 8/

Number of Firms by Size and Type of Manufacturing
Collin, Kaufman, and Rockwall Counties, Texas
1947 and 1954

| Type of Manufacturing Firm | Number with 1-19 employees | | Number with 20-99 employees | | Number with 100 & over employees | |
|---|---|---|---|---|---|---|
| | 1947 | 1954 | 1947 | 1954 | 1947 | 1954 |
| Food and kindred products | 17 | 14 | 6 | 3 | - | 1 |
| Textile mill products | - | - | - | - | 1 | 1 |
| Apparel and related products | 2 | 3 | 1 | 5 | - | - |
| Lumber and wood products | - | - | - | 1 | - | - |
| Furniture and fixtures | 2 | 1 | - | - | - | - |
| Pulp, paper and products | 1 | - | - | - | - | - |
| Printing and publishing | 12 | 13 | 1 | - | - | - |
| Chemicals and products | 1 | - | 2 | 1 | - | - |
| Rubber products | - | - | - | 1 | - | - |
| Leather and leathergoods | - | 1 | 1 | 1 | - | 1 |
| Stone, clay and glass products | 1 | - | - | - | - | - |
| Primary metal industries | - | - | - | 2 | - | - |
| Fabricated metal products | - | - | - | 2 | - | - |
| Machinery, except electrical | - | - | 1 | 1 | - | - |
| Transportation equipment | - | - | - | 1 | - | - |
| Miscellaneous manufactures | 1 | 1 | - | - | - | - |

The above shows the nucleus of a highly diversified manufacturing complex. While the increase in manufacturing capacity and employment has not been spectacular in the tri-county area, it has been significant. Between 1947 and 1954, the manufacturing employment for the tri-county area has increased some 53 per cent, and the value added by manufacture for the same period has increased by approximately $6,000,000. In general, the manufacturing in the area is oriented to the market rather than to the resource, the major exception being food and kindred products.

It is not possible to break down the published data on manufacturing for Dallas County to obtain data for only the portion of the county within the study area. The aircraft and electronics industries form a significant part of the Dallas industrial complex.

## Retail Trade and Service Establishments [9]

Commercial and industrial development go hand in hand. Between 1948 and 1958, the retail and service industry in the tri-county area experienced a sales volume increase of 23 per cent, adjusted to the 1948 dollar base. The number of establishments and the number of employees increased only 10 per cent each, indicating an increase in the sales volume per establishment and per employee. In Dallas County, the same trend was noted with sales volume, adjusted to the 1948 base, up 67 per cent, while the number of employees and establishments each increased in the order of 50 per cent.

Table 6 [9] illustrates the growth of sales in the retail and service industry for the tri-county area and Dallas County. Since the study area includes only the northwest corner of Kaufman County, figures for the cities of Kaufman and Terrell were excluded from the totals shown.

Table 6 [9]

Total Sales Volume of the Retail and Service Industry
Tri-County Area and Dallas County
1948 and 1958

| | 1948 | 1958 Adjusted* | 1958 |
|---|---|---|---|
| Collin County | $ 26,606,000 | $ 32,697,000 | $ 39,281,000 |
| Kaufman County (exclusive of Terrell and Kaufman) | 5,685,000 | 6,282,000 | 7,548,000 |
| Rockwall County | 3,650,000 | 5,209,000 | 6,258,000 |
| Total, Tri-County Area | $ 35,941,000 | $ 44,188,000 | $ 53,087,000 |
| Dallas County | $765,555,000 | $1,277,142,000 | $1,534,289,000 |

*Adjusted to the 1948 value of the dollar

## Population

The trend toward urbanization, with Dallas as the focal point, is clearly evident in the study area. Between 1940 and 1960, the tri-county area population decreased 17 per cent, while Dallas County population soared, increasing 137 per cent. Within the tri-county area, population in the cities and towns has increased more modestly. The group of municipalities used in the calculations had a combined population in 1940 of 17,624. In 1960, the preliminary census total was 26,702, an increase of 51 per cent.

Prior to 1920, the tri-county area showed a population increase in both the municipalities and rural areas. The significance of the urbanizing trend is indicated by the relative number living in cities and towns. In 1910, 23 per cent of the population lived in municipalities, whereas the preliminary 1960 census shows 57 per cent are city dwellers. This increase takes on more significance in the light of these counties being centered in one of the State's chief farming areas.

Table 7 [10/] shows the trends of the tri-county area total population, tri-county area urban population, and Dallas County population.

Table 7 [10/]

Population Trends of the Tri-County Area, Tri-County Area Urban Population, and Dallas County 1910 - 1960

| Year | Populations | | |
|---|---|---|---|
| | Tri-County Total | Tri-County Urban | Dallas County |
| 1910 | 92,416 | 11,764 | 135,748 |
| 1920 | 99,476 | 17,527 | 210,551 |
| 1930 | 94,743 | 18,381 | 325,691 |
| 1940 | 92,549 | 21,690 | 398,564 |
| 1950 | 79,018 | 24,818 | 614,799 |
| 1960 | 76,884 | 34,131 | 942,563 |

From the above, it becomes clearly evident that while the Dallas County population and the tri-county area urban population continued to rise, the tri-county area total population reached its highest point in 1920 and has continuously declined since.

For the purposes of determining water needs, the cities considered are separated into a metropolitan and a non-metropolitan group. This is due to the influence of the city of Dallas on the water consumption and growth of contiguous areas, as opposed to the water consumption and growth of more distant municipalities.

A population center of the size of Dallas usually attracts to itself a group of so-called "bedroom" cities which are, wholly or at least for the most part, dependent on the large city for their very birth and existence. These areas are actually designed as nothing but extensions of the parent city under the guise of preventing encroachment by a "monster" central city. They nevertheless are like the city in many characteristics including water use and population growth, differing greatly from the non-contiguous independent municipalities in these respects. For reference hereinafter, the metropolitan group will include the cities of Garland, Mesquite, Sunnyvale, Rowlett, and Sachse in Dallas County, and Plano in Collin County; and the non-metropolitan group will consist of McKinney, Princeton, Farmersville, Wylie, and part of Royse City in Collin County; Fate, Rockwall, and part of Royse City in Rockwall County; and Forney in Kaufman County.

Of the metropolitan group, Garland and Mesquite are examples of the growth that can occur. Garland grew from a town of 2,223 in 1940 to 38,103 in 1960, and Mesquite expanded even more rapidly from 1,696 in 1950 to 27,345 in 1960. Further investigation discloses that most of the increase in Mesquite took place in the three years between 1957 and 1960.

High growth rates such as these are not uncommon around today's cities. This is due primarily to modern methods of development. Dwelling units are planned and constructed in groups at high rates to utilize all of the available area in a given tract of land in a very short time. Consequently, an area rapidly becomes saturated and the growth rate levels off and probably becomes negative for the next census period. An example of this growth pattern is to be had in the "Park Cities" of Highland Park and University Park. These are completely surrounded by the city of Dallas with no room for expansion. Highland Park increased steadily from a population of

2,321 in 1920 to a maximum of 11,405 in 1950. The 1960 population shows a small drop to 10,287. Similarly, University Park grew from 4,200 in 1930 to a maximum of 24,275 in 1950, and showed a drop to 22,969 in 1960.

## Future Growth

### Projected National Population

The population of the United States is projected to double in 47 years. The growth rate of a local region will depend largely on its endowment with the factors which affects its relative competitive advantage over other areas in furnishing goods and services.

### Projected Economic Growth of the Area

The expectations for an economic expansion of the area rely upon the growth of its several elements. The agricultural output, including livestock and related products of the area, is expected to rise only slightly above the present level, while greater mechanization will cause the number of agricultural employees to drop. The manufacture of food and kindred products, at present the largest industry in the area, is expected to increase considerably. Since Dallas has long been the leading manufacturing apparel center of the Southwest, it can be anticipated that this industry will expand into surrounding counties -- a trend already evident. A substantial increase is expected for the industries dealing with stone, clay, and glass products. The building boom in the area provides a ready market for these products. An abundance of limestone, clays, and marls, coupled with the building boom, can support an expansion of Portland cement manufacturing around Dallas. The sand and gravel processing industry may also be expected to grow, as well as lightweight aggregate production from shales and clays, both local and imported. With total interior climate control as a goal, the local manufacture of equipment for both heating and cooling and components thereof will probably increase considerably. The aircraft and electronic industries presently located in the area show excellent possibilities for expansion.

In general, it may be said that the outlook for industry in the study area is excellent from both a resource and market viewpoint

and the growth of the several communities in total will be a function of the growth of the Dallas economic area. Transportation in the area is at present very good and, due to the proximity to the Dallas population center, can be expected to expand with the area. Nearby Dallas provides a center for rail and air transport directly to other population centers of the United States, and will undoubtedly grow proportionally with the needs of the area.

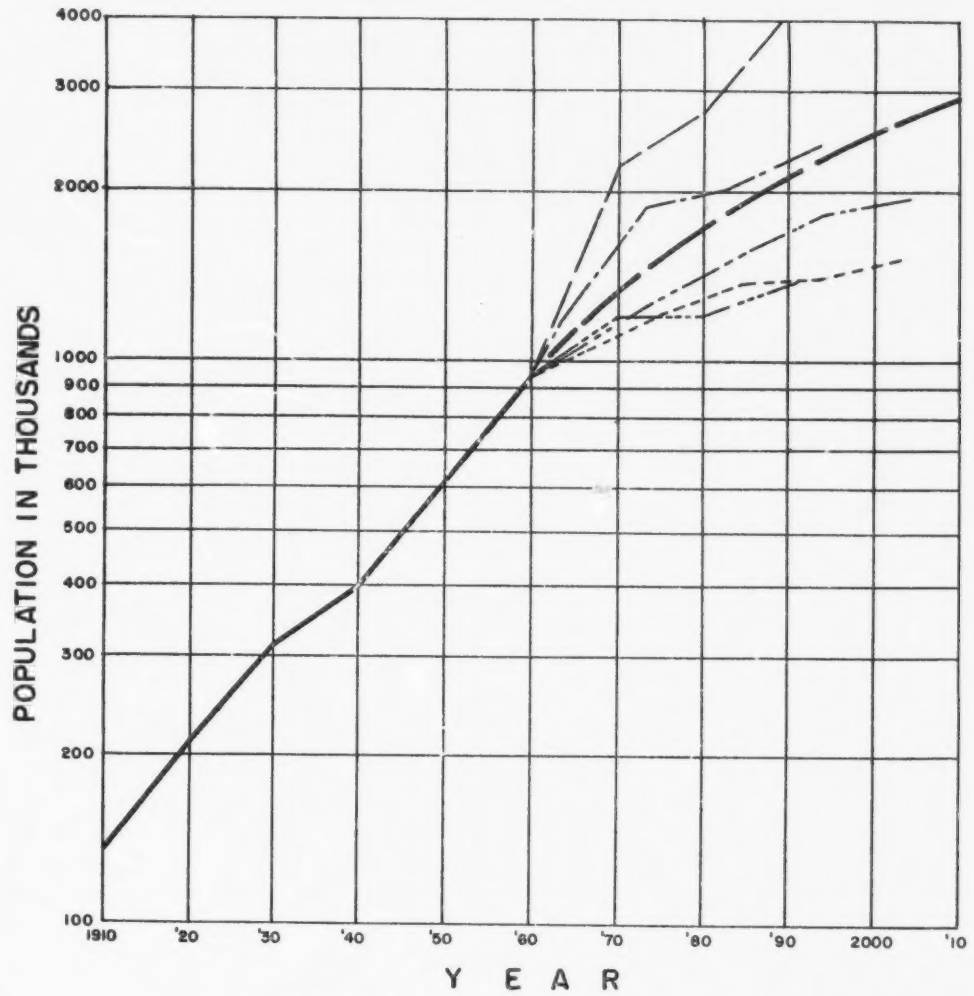
Electric power and fuel, mainly in the form of natural gas, will be available to meet needs of all, except industries with extremely large requirements.

## Population Projections

Population projections were made for Dallas County, the metropolitan group, and the non-metropolitan group. For Dallas County, the projection was made by comparison of (1) past growth rates of Dallas County; (2) growth rates of other counties whose population had reached the last census figure of Dallas County in the past 50 years; and (3) accepted growth rates of the United States and the State of Texas. Also considered was the resource of potential of the county.

A special method for the projection of the metropolitan group population was used, which was necessarily complicated since growth in this group will probably take place without regard for the political boundaries used for census figures. An assumed density of 5,000 persons per square mile was used in establishing a saturated population density for the central core of the city of Dallas, and the assumption made that the core would reach this condition in 50 years. Subtracting this "saturated core" population from the total increase projected for Dallas County in 2010 (see Figure 2) gives the portion of that increase which, it is assumed, will occur in the fringe area. As a final assumption, one-fifth of this increase was apportioned to the study area. Adding this to the present population then gives the projected 2010 population for the metropolitan group. Results are given in Table 9 and shown on Figure 3.

The population of the non-metropolitan group was projected as shown on Figure 4, using the past growth rates of the group, and projected future rates for the State of Texas, and the United States as guides. Examination of Figure 4 will show that the adopted growth rate is somewhat less than the average rate for Texas as a whole, and greater than the national average.




LEGEND

- LOS ANGELES COUNTY, CALIFORNIA
- WAYNE COUNTY, MICHIGAN
- PHILADELPHIA COUNTY, PENNSYLVANIA
- CUYAHOGA COUNTY, OHIO
- ALLEGHENY COUNTY, PENNSYLVANIA

LAVON RESERVOIR

POPULATION PROJECTION

DALLAS COUNTY

U.S. DEPARTMENT OF HEALTH, EDUCATION, & WELFARE

PUBLIC HEALTH SERVICE

REGION VII DALLAS, TEXAS

mfk

FIGURE 2

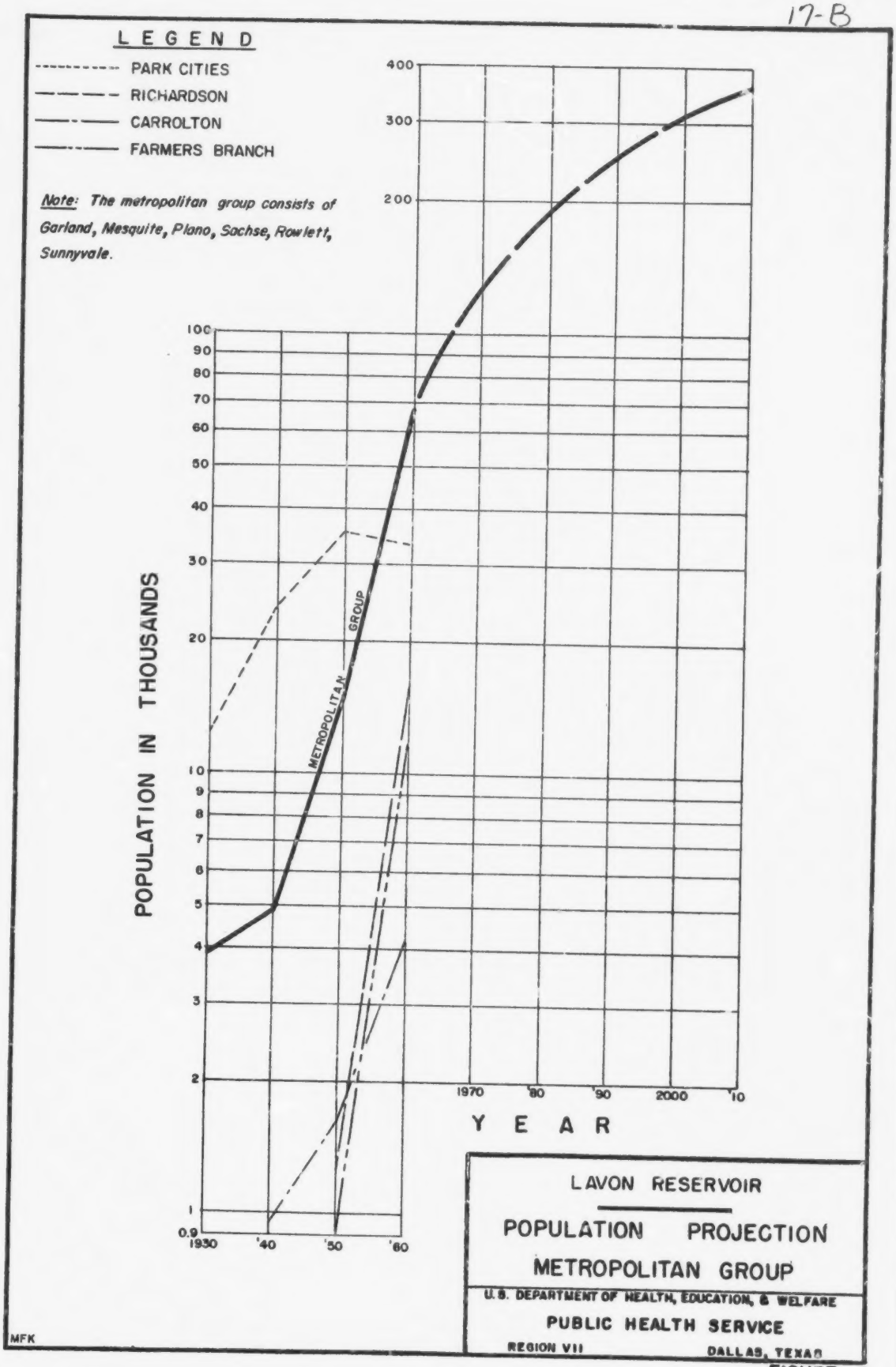
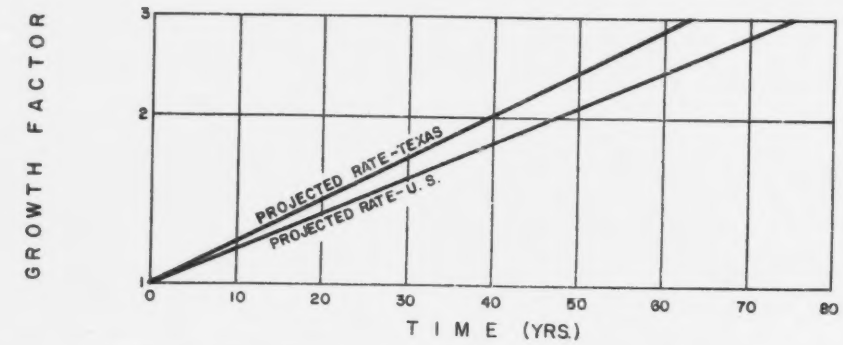
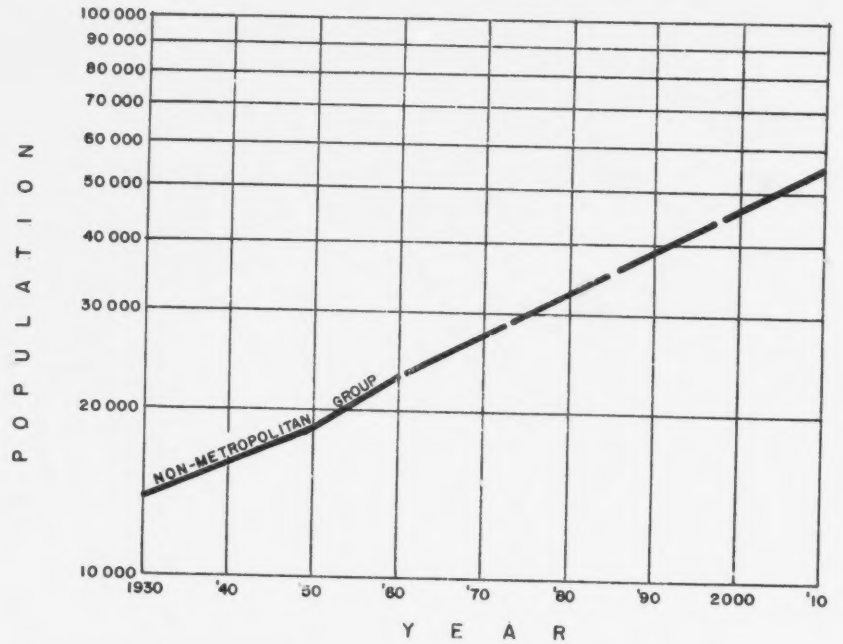

LEGEND
PARK CITIES
RICHARDSON
CARROLTON
FARMERS BRANCH
Note: The metropolitan group consists of Garland, Mesquite, Plano, Sachse, Rowlett, Sunnyvale.
POPULATION IN THOUSANDS
METROPOLITAN GROUP
YEAR
1930
'40
'50
'60
1970
'80
'90
2000
'10
LAVON RESERVOIR
POPULATION PROJECTION
METROPOLITAN GROUP
U.S. DEPARTMENT OF HEALTH, EDUCATION, & WELFARE
PUBLIC HEALTH SERVICE
REGION VII
DALLAS, TEXAS
MFK

FIGURE 3




*Note:* *The non-metropolitan group consists of McKinney, Princeton, Farmersville, Wylie, Royse City, Fate, Rockwall, and Forney.*

LAVON RESERVOIR

POPULATION PROJECTION

NON-METROPOLITAN GROUP

U.S. DEPARTMENT OF HEALTH, EDUCATION, & WELFARE

PUBLIC HEALTH SERVICE

REGION VII DALLAS, TEXAS

FIGURE 4

# VI. WATER REQUIREMENTS

## Past and Present Water Use

The 1959 water requirements of the area obtained from the North Texas Municipal Water District are given below in Table 8. No attempt is made to separate municipal and industrial usage, because of the predominance of "dry" industries in the area. Examples of these are apparel, aircraft, electronics, and printing, whose operations require little or no water.

Table 8

Study Area Water Requirements - 1959

| Item | 1960 Population | Total avg. Daily Water (mgd) |
|---|---|---|
| Metropolitan Group | 60,500 | 5.99 |
| Non-Metropolitan Group | 22,990 | 1.62 |
| Furnish to Dallas (Contract N.T.M.W.D.) | | 7.50 |
| Sub-Total | | 15.11 |
| Unaccounted-for Water | | 1.11 |
| Total Required | | 16.22 |

## Existing Sources

The water presently used in the area comes from Lavon Reservoir through North Texas Municipal Water District facilities except for small quantities from ground water sources and from the city of Dallas used by the city of Mesquite.

At present, the conservation storage pool in Lavon Reservoir contains 100,000 acre-feet. This will provide a firm yield of 44 mgd, according to the Corps of Engineers.

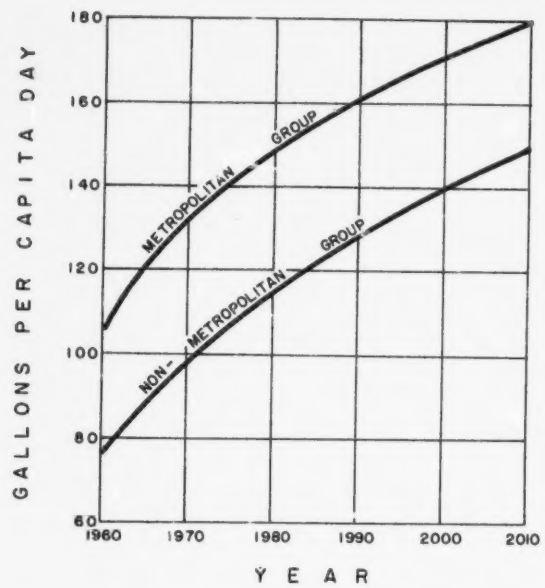
The quality of the water is suitable for municipal and industrial consumption in all respects after treatment in the North Texas Municipal Water District plant at Wylie, Texas. A chemical analysis of the raw water in 1959 was previously shown in Table 1.

Ground water amounted to approximately 8 per cent of the municipal and industrial water used in the study area in 1957. 12/ The study area overlies the underground aquifer known as the Trinity and Woodbine sands group. The Woodbine sand outcrops between Dallas and Fort Worth. At Dallas, it is 600 to 800 feet deep, and at Rockwall about 1,800 feet below the surface. 13/ Due to the comparatively low permeability of the sands and their consequent limited ability to transmit water, large declines in artesian pressure have occurred in the formations where the draft has been heavy. Water drawn from these aquifers is suitable for consumption, and except for chlorination, usually receives no treatment.

## Additional Water Needs

Per capita water consumption rates have been rising as is borne out by past records of use. One reason for increase becomes apparent when consideration is given to the large number of water-consuming devices that have come into common use in the home. A thorough study of the area's water consumption, however, failed to show enough correlation between various factors to establish definite trends for future projections.

In view of the above, per capita consumption rate projections for the year 2010 are based on judgment and are estimated to be 180 gpcd for the metropolitan group and 150 gpcd for the non-metropolitan group, as shown in Figure 5. These figures are for raw water and include losses incurred in treatment and distribution. Similarly, the 1975 estimates are 142 and 108 gpcd. Projections for the area made by several consulting engineers and other governmental agencies were found to be in close agreement with the adopted figures. Since no large water-using industries are expected to locate in the area in the future, no differentiation is made between domestic and industrial rates, rather a single figure is used for the total water used as was done previously in Table 7. Table 9 shows the future water requirements of the study area. It is assumed that the contract to furnish water to the city of Dallas will be renewed by the North Texas Municipal Water District, and that any water over and above the needs of the District will be purchased by the city of Dallas.




LAVON RESERVOIR

PROJECTED PER CAPITA WATER USE

U.S. DEPARTMENT OF HEALTH, EDUCATION, & WELFARE
PUBLIC HEALTH SERVICE
REGION VII DALLAS, TEXAS

MFK

FIGURE 5

Table 9

Study Area Future Water Requirements

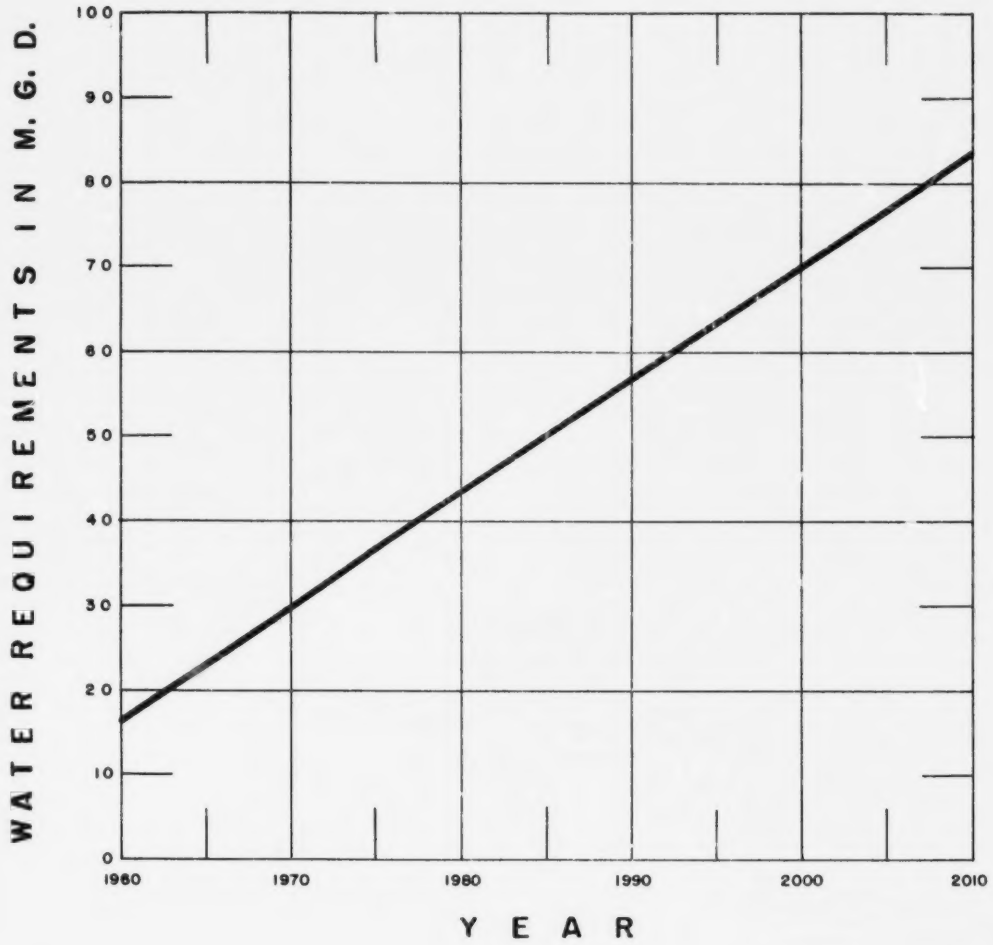
| | Projected Population | Projected Water Requirements gpcd | mgd |
|---|---|---|---|
| | YEAR 1975 | | |
| Metropolitan Group | 160,000 | 142 | 22.7 |
| Non-Metropolitan Group | 30,000 | 108 | 3.2 |
| Furnish to Dallas (Contract N.T.M.W.D.) | | | 10.8 |
| TOTAL | | | 36.7 |
| | YEAR 2010 | | |
| Metropolitan Group | 356,000 | 180 | 64.1 |
| Non-Metropolitan Group | 55,000 | 150 | 8.3 |
| Furnish to Dallas (Contract N.T.M.W.D.) | | | 10.8 |
| Subtotal | | | 83.2 |
| Excess available water assumed furnished to Dallas | | | 6.8 |
| TOTAL | | | 90.0 |

A concurrent study by the Public Health Service [17] which includes the Dallas - Fort Worth area shows that Dallas and Fort Worth will require not only all of the available water in the upper Trinity River basin but also any excess water from other nearby watersheds.

Figure 6 shows the municipal and industrial water requirements for the study area from the year 1960 to the year 2010. This shows that the present reservoir is adequate until the year 1980.

## Stream Quality Maintenance

At present, wastes from 15 cities and towns enter the East Fork of the Trinity River. Of these, 10 are downstream of Lavon




LAVON RESERVOIR

PROJECTED M. & I. WATER REQUIREMENTS FOR STUDY AREA

U.S. DEPARTMENT OF HEALTH, EDUCATION, & WELFARE

PUBLIC HEALTH SERVICE

REGION VII DALLAS, TEXAS

FIGURE 6

Reservoir and contribute approximately 2,000 pounds of BOD per day; and 5 are upstream and contribute approximately 500 pounds of BOD per day. This is but a small portion of the total waste load entering the Trinity River in this vicinity. The main stem of the river is reported to be grossly polluted at present 18/ by wastes from the entire Dallas - Fort Worth complex.

Present waste treatment in the area ranges from septic tanks to highly efficient secondary treatment plants. Where conditions dictate, most present treatment facilities are being improved and enlarged in an effort to solve the existing pollution problem.

In the future, impoundments on the river and its tributaries upstream of Dallas - Fort Worth will absorb all water except the most localized runoff. Futhermore, all of this impounded water, and probably water from several sources outside the Trinity River Basin, will have been allocated to storage of water to meet municipal and industrial demands, leaving nothing for the maintenance of stream quality. Simply stated, all indications are that the Trinity River in the vicinity of Dallas and Fort Worth and for a considerable distance downstream may be expected to be of low quality that will limit its usefulness to a significant degree.

Since this study deals with but a small segment of the overall area, it is felt that the water pollution problem of the Trinity River is not the responsibility of the conservation storage lessee of Lavon Reservoir. Therefore, any attempt at a solution to the problem would necessarily involve the entire Dallas - Fort Worth area and is beyond the scope of this report.

## Plan for Supplying Future Requirements

Lavon Reservoir at present has a firm yield in the 100,000 acre-foot conservation pool of 44 mgd. The Corps of Engineers estimates that the storage can be increased to a maximum of 360,000 acre-feet yielding 90 mgd. It is supplying good quality water at present, as attested by Table 1, and there are no reasons to expect a change for the worse in the future, provided that upstream pollution is controlled.

Ground water sources accounted for approximately 8 per cent of the municipal and industrial water used in the area in 1957. 12/ The United States Study Commission - Texas estimates that the study

area contains some 4,000 acre-feet per year of available ground water for municipal and industrial needs. This would amount to approximately 4 per cent of the projected municipal and industrial needs for the year 2010.

Alternative water sources for the study area are located in other river basins and must be pumped if made available to meet demands in Lavon Reservoir. The nearest watershed area with available water is the Sulphur River Basin, and more specifically, the proposed Cooper Reservoir. A great deal of municipal and industrial water could be made available from the Red River when its salt and gypsum pollution problem is solved, but at this time it is not possible to say when this will be accomplished. Further water supplies, should they become necessary, would have to be obtained from the Southeast Oklahoma area. These, however, would become available only when and if legal barriers and those of sectional public sentiment are removed.

# VII. BENEFITS OF STORAGE

## Evaluation Method

The 1958 report [14] of the Subcommittee on Evaluation Standards states: "From an overall public viewpoint, a water supply development will be justified if it provides water to meet expected needs at a cost not greater than the cost of alternative sources that would probably be utilized in the absence of the project."

## Alternative Plan

In keeping with the above, Cooper Reservoir on the South Sulphur River was adopted as the alternative plan because of (1) its proximity to the area and (2) its conservation storage capacity available. A companion report [15] by the Public Health Service shows that the proposed Cooper Reservoir developed to its optimum size includes ample available storage capacity to meet the needs of the Lavon Reservoir study area in the year 2010. Table 10 shows the costs and value of augmented storage in Lavon Reservoir adjusted to the year 1970. The year 1970 was used because the Corps of Engineers estimates it to be the earliest possible completion date for the project. The benefits of augmented storage in Lavon Reservoir are equal to the cost of storage in Cooper Reservoir plus the cost of transmission to the terminal reservoir (Lavon). A treatment cost differential is not expected as quality of the two waters is approximately equal. The plan for transmission was adapted from the report to the North Texas Municipal Water District [17] by Forrest and Cotton, Inc., Consulting Engineers, Dallas, Texas, dated April 29, 1960.

Table 10

Alternative Costs and Value

| | | |
|---|---|---|
| Proposed Total Yield | 90 mgd | |
| Yield from existing Lavon Reservoir | 44 mgd | |
| Proposed Additional Yield | 46 mgd | |
| Annual Storage Cost at Alternative Site | | $260,000 |
| Annual Transmission Costs (Deferred costs, discounted 10 yrs @ 4% to 1970) | | 495,000 |
| 1970 Value of Annual Benefits | | $755,000 |
| | | OR 4.49¢ per 1,000 gal. |

Benefits from additional storage would not begin to accrue until about 1980 when the present reservoir becomes inadequate. The benefits arrived at for 1980 are discounted at 4 per cent for 10 years to 1970, which is the earliest possible date of completion, according to the Corps of Engineers. Based on the above, the annual value of augmented storage to increase the firm yield of Lavon Reservoir from 44 mgd to 90 mgd is $755,000. Calculations, as shown in the Appendix, for the value of storage were based on comparison with the alternative source in Cooper Reservoir.

# APPENDIX

EXHIBIT A-1

## Calculations Used for Alternative Cost Determination

Alternative - Cooper Reservoir

I. Storage cost: use single-purpose reservoir to yield:

16.6 mgd for Sulphur River M.W.D. [15]
46.0 mgd for North Texas M.W.D.

Total 62.6 mgd = 70,000 acre-feet per year

From COOPER RESERVOIR AND CHANNELS [16] by Forrest and Cotton

the required water supply storage = 85,000 ac-ft
drainage area = 476 sq. mi.
silt load = 0.8 ac-ft/yr/sq. mi

then sediment storage = (476) (0.8) (50) (0.60) = 11,400 ac-ft

therefore: total storage required = 96,400 ac-ft

from cost-capacity curve [16] estimated cost = $70/ac-ft

Total = $6,750,000

pro-rated for the 46 mgd required for Lavon =

46/62.6 ($6,750,000) = $4,968,000

amortizing 50 yrs. @ 4% interest, the

| | |
|---|---|
| annual storage cost becomes | $231,000 |
| plus estimated operation & maintenance | 29,000 |
| or the total annual storage cost = | $260,000 |

EXHIBIT A-2

II. Transmission cost

A. Pipe line (adapted from the report to N.T.M.W.D.) 17/

48" reinforced concrete pressure pipe

| | | |
|---|---|---|
| Class 150 - 13 miles @ $165,000/mi | = | $2,150,000 |
| Class 100 - 10 miles @ $151,000/mi | = | $3,020,000 |
| 42" reinforced concrete pressure gravity line | | |
| 4 miles @ $75,500/mi | = | $ 302,000 |
| Channel improvement - 3 miles @ $10,000 | = | $ 30,000 |
| Right of way - 40 miles @ $1,500 | = | $ 60,000 |
| SUBTOTAL | | $5,562,000 |
| Administration, engineering, contingencies and interest during construction (20%) | = | $1,110,000 |
| TOTAL CONSTRUCTION COST | | $6,672,000 |
| Annual capital cost, pipeline (50 yrs @ 4%) | = | $ 310,600 |
| plus estimated maintenance cost of $75/mi/yr | say | $ 3,000 |
| | | $ 313,600 |

B. Pumping equipment

| | | |
|---|---|---|
| Primary pumping station | = | $ 450,000 |
| Booster pumping station | = | $ 365,000 |
| TOTAL | | $ 815,000 |
| plus estimated maintenance (1.75%) | = | $ 142,600 |
| | | $ 957,600 |
| annual cost (amortizing 25 yrs @ 4%) | = | 61,300 |
| Total annual capital cost of transmission IIA + IIB | = | $ 374,900 |

EXHIBIT A-3

C. Energy Costs

Static head:

| | |
|---|---|
| Elev. Divide Approx. | 660' |
| Avg. lake level | 424' |
| Static head | 236' |
| Friction loss @ 46 mgd (H - W "C" = 140) | 270' |
| Total head @ 46 mgd | 506 ft. |

Assume energy cost = $0.012 per KWH

Therefore, annual energy cost for pumping 46 mgd = $510,000
and average annual energy cost =

$$\frac{510{,}000\ (20) + 510{,}000\ (0.5)\ (30)}{50} = \$357{,}000$$

SUMMARY

| | | |
|---|---|---|
| Storage cost - Cooper Reservoir | | $260,000 |
| Transmission (deferred cost) | | |
| Capital | $374,900 | |
| Energy | $357,000 | |
| | $731,900 | |
| Value of transmission cost in 1970 (need deferred 10 years from 1970 to 1980) Discounting 10 yr @ 4% | | = $495,000 |
| Present worth of annual benefits in 1970 | | = $755,000 |

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